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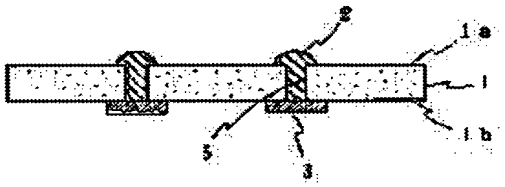
(71)Applicant : NITTO DENKO CORP
(72)Inventor : AZUMA KAZUMI
HINO ATSUSHI

(54) PROBE, AND CIRCUIT BOARD FOR PROBE

(57)Abstract:
PROBLEM TO BE SOLVED: To improve the contact reliability under service condition at a high temperature as in a burn-in test, and enhance the durability of an inspection equipment, by constituting a structure wherein a contact part of one surface of a flexible board is electrically connected with a conducting circuit, and setting the difference between the coefficient of linear expansion of the flexible board material and that of the contact object of a prove, as a specified value.



SOLUTION: Through holes 5 are formed at positions corresponding to the just rear of a conducting circuit 3 on the surface 1a of a flexible board 1. The conducting circuit 3 on the rear 1b is exposed on the bottom surfaces in the through holes. The surfaces of the conducting circuit 3 which are exposed on the bottom surfaces in the holes are used as a negative electrode, and electroplating is performed. Thereby good conductor metal such as gold, silver and copper which are used as the material of bump contact is deposited in the through holes 5 and buried. The good conductor metal is protruded from the board 1 surface, and bump contacts 2 are formed. Polyimide is preferably used as material of the board 1. The difference between the coefficient of linear expansion of the board 1 material and that of a contact object is set at most 10×10-6 at 25-300° C.

LEGAL STATUS

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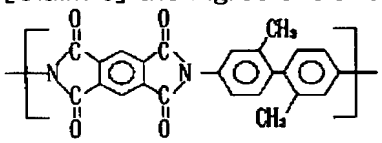
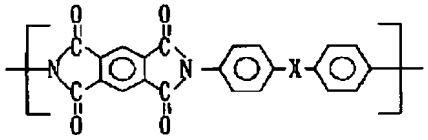
CLAIMS

[Claim(s)]
[Claim 1] The probe with which it has the structure where the conductive circuit established in the contact surface prepared in one [which has insulation] field of a flexible substrate, and one of the fields or the interior of this flexible substrate flowed, and the difference of the coefficient of linear expansion of the ingredient of said flexible substrate and the coefficient of linear expansion of the contact object of the probe concerned is characterized by being 10x10 to six or less in 25 degrees C - 300 degrees C.
[Claim 2] The probe according to claim 1 whose coefficient of linear expansion of the ingredient of the above-mentioned flexible substrate the contact objects of the probe concerned are the electronic parts which have the coefficient of linear expansion of a silicon crystal, and is 1x10-6 to 10x10-6.
[Claim 3] the ingredient of a flexible substrate — formula (A): — [Formula 1]



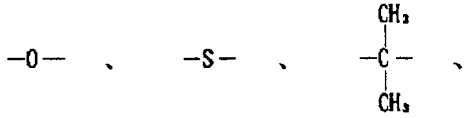
(A)

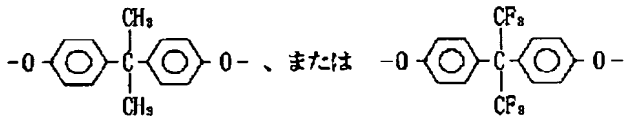
The structural unit (A) come out of and expressed, and a formula (B): [Formula 2]



(B)

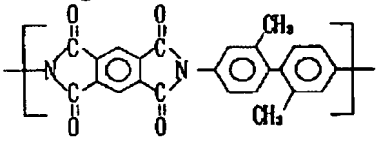
(The inside of a formula and X are [Formula 3].)





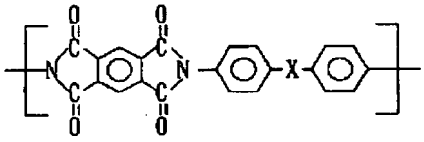
the radical come out of and expressed — being shown — the probe according to claim 2 whose mole ratio of a structural unit (A) and a structural unit (B) it consists of a structural unit (B) expressed, and is polyimide of (A): (B) =90:10-50:50.
[Claim 4] The probe according to claim 1 which is the circuit of the structure where the laminating of the layer which a conductive circuit is a circuit formed with the iron nickel alloy, or consists of an iron nickel alloy by the side of a flexible substrate, and the layer which consists of a good conductor metal by the side of a surface was

carried out.
[Claim 5] a conductive circuit prepares in one [which has insulation] field of a flexible substrate — having — the ingredient of a flexible substrate — formula (A): — [Formula 4]



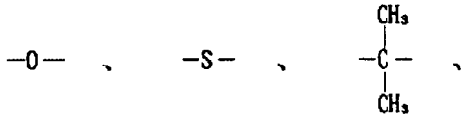
(A)

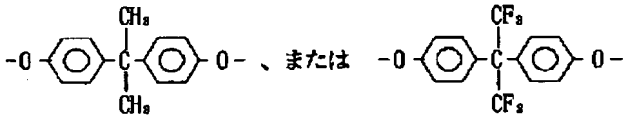
The structural unit (A) come out of and expressed, and a formula (B): [Formula 5]



(B)

(The inside of a formula and X are [Formula 6].)





the radical come out of and expressed — being shown — the circuit board for probes characterized by to be the circuit of the structure where of consisted of a structural unit (B) expressed, and the mole ratio of a structural unit (A) and a structural unit (B) is polyimide of (A):(B) =90:10-50:50, and the laminating of the layer which a conductive circuit is a circuit formed with the iron nickel alloy, or consists of an iron nickel alloy by the side of a flexible substrate, and layer which consists of a good conductor metal by the side of a surface be carried out.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the probe which performs electric contact to detailed contact objects, such as an integrated circuit.
[0002]
[Description of the Prior Art] With the miniaturization of electronic equipment in recent years, and thin-shape-izing, the miniaturization also with the more and more semiconductor devices, such as IC carried there, is required, and it has been required that the component-side product of a semiconductor device should also be

made small even at a limit. As one of the replies to such a demand, the semiconductor device (the thing of the divided phase is hereafter called a bare chip) of the phase formed on the silicon wafer or the divided phase is not packed, but it remains as it is, and bare chip mounting which mounts in a substrate is performed, and it is thought that the shift to this mounting gestalt will progress quickly from now on. [many] Moreover, even mounting with a wafer condition is going to be performed in the future. Therefore, the various quality measurement to a semiconductor device, a trial, especially the burn in test performed to the bottom of a severe hot condition for a semiconductor device must also be performed in the state of the wafer which is a bare chip or its preceding paragraph story.

[0003] the detailed electrode formed on contact objects, such as the above-mentioned bare chip and a wafer, and a conductor — for performing electric contact, a probe is used to the contacted sections, such as a part. The probe as used in the field of this invention is a field-like probe with which the probes which have a mechanical needle type device differ. The structure has the common structure where the conductive circuit established in the contact surface prepared in one [which has insulation] field of a flexible substrate, and one of the fields or the interior of this flexible substrate flowed. The contact surface of a probe is a part which performs electric contact to the contacted section, and is the good conductor metal contact of the letter of a projection usually called a bump contact (or only bump).

[0004]

[Problem(s) to be Solved by the Invention] Where a probe is conventionally contacted to a contact object, when a big temperature change is given, the difference of the coefficient of linear expansion of a contact object and the coefficient of linear expansion of a probe may become a problem. When performing the burn in test of a bare chip as a checking probe especially, where a probe is contacted to a bare chip, depending on 120 degrees C - about 150 degrees C and the case, it is usually heated by even the about 200-degree C elevated temperature. In such a case, in the conventional probe, since the coefficient of linear expansion of this probe differed from the coefficient of linear expansion of a contact object greatly mutually, there was a problem that the contact surface of the probe which touched the contacted section on a contact object in the state of the room temperature at the time of test initiation shifted from a partner's contacted section after a temperature rise, and it became impossible a flash, a poor contact, and inspecting it.

[0005] Moreover, by shifting covering die length of dozens of micrometers with the condition that the contact surface of a probe contacted the contacted section, even if it does not result by the degree which the contact surface of a probe shifts and protrudes from the contacted section The contacted section of a contact object was damaged greatly and there were a problem that the quality as a product deteriorates greatly, and a problem that the contact surface of a probe was damaged by reverse by the contacted section, and the endurance as test equipment fell.

[0006] The technical problem of this invention is offering the circuit board which is a member for manufacturing the probe and this which have the endurance which solved the above-mentioned problem, could contact the contact object with the contact dependability which was excellent under the service condition in the elevated temperature in a burn in test etc., and was excellent also as checking.

[0007]

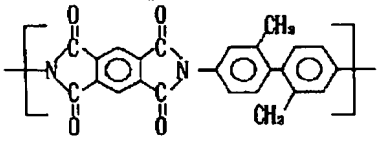
[Means for Solving the Problem] this invention persons completed this invention paying attention to bringing the coefficient of linear expansion of the flexible substrate itself close with the coefficient of linear expansion of a contact object rather than controlled the thermal expansion of a flexible substrate using the rigid substrate etc. When it was the semiconductor device to which a contact object uses a silicon crystal as a substrate especially, the polyimide optimal as an ingredient of a flexible substrate was specified. Moreover, when the polyimide optimal as an ingredient of a flexible substrate was specified, according to the difference of the coefficient of linear expansion of a flexible substrate and a conductive circuit, the curvature newly generated in the whole circuit board and probe was made into the further problem, this was solved, and the usefulness of this invention was raised more.

[0008] The probe and the circuit board of this invention have the following description.

(1) The probe with which it has the structure where the conductive circuit established in the contact surface prepared in one [which has insulation] field of a flexible substrate, and one of the fields or the interior of this flexible substrate flowed, and the difference of the coefficient of linear expansion of the ingredient of said flexible substrate and the coefficient of linear expansion of the contact object of the probe concerned is characterized by being 10x10 to six or less in 25 degrees C - 300 degrees C.

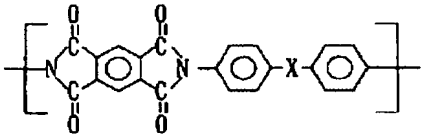
[0009] (2) The probe of the above-mentioned (1) publication whose contact objects which are the probe

concerned are the electronic parts which have the coefficient of linear expansion of a silicon crystal and whose coefficient of linear expansion of the ingredient of the above-mentioned flexible substrate is 1x10-6 to 10x10-6.
[0010] (3) The ingredient of a flexible substrate is formula (A): [0011].
[Formula 7]



(A)

[0012] The structural unit (A) come out of and expressed, and formula (B) : [0013]
[Formula 8]

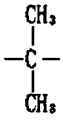


(B)

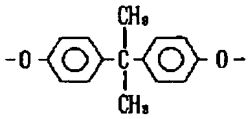
[0014] the inside of a formula, and X — bottom (type i) -(v): [0015]
[Formula 9]

(i)

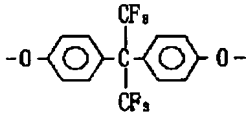
(ii)



(iii)



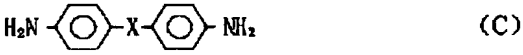
(iv)



(v)

[0016] one radical which comes out and is chosen from radical (i) - (v) expressed — being shown — from the structural unit (B) expressed — becoming — the mole ratio of a structural unit (A) and a structural unit (B) — a probe given in (A):(B) = above-mentioned [which is polyimide of 90:10-50:50] (2).
[0017] (4) conductivity — a circuit — an iron nickel alloy — forming — having had — a circuit — it is — or — or — flexible — a substrate — a side — an iron nickel alloy — from — becoming — a layer — a surface — a side — a good conductor — a metal — from — becoming — a layer — a laminating — carrying out — having had — structure — a circuit — it is — the above — (— one —) — a publication — a probe .
[0018] (5) The circuit board for probes to which a conductive circuit is established in one [which has insulation] field of a flexible substrate, and the ingredient of a flexible substrate is polyimide given in the above (3), and is characterized by being the conductive circuit are given [a conductive circuit] in the above (4) in a circuit.
[0019] The probe of this invention includes what [not only] contacts temporarily to a contact object like a checking probe but the connecting means used while it had been made to contact eternally to a contact object as objects for mounting, such as a bare chip.
[0020]
[Function] Even if it uses as a checking probe and is exposed to the temperature change from a room temperature like a burn in test to an elevated temperature by making the difference of the coefficient of linear expansion of the ingredient of a flexible substrate, and the coefficient of linear expansion of the contact object

of the probe concerned or less into 10x10 to six in 25 degrees C - 300 degrees C, the gap with the contact surface of a probe and the contacted section of a contact object can be controlled suitably.
[0021] Concluding especially that such coefficient of linear expansion is equivalent to the coefficient of linear expansion of the silicon crystal used as a crystal substrate when contact objects are the electronic parts which have the detailed contacted sections, such as bare chips, wafers, etc., such as a semiconductor device and an integrated circuit, the value is 3.5x10 to about six in a 0 degree C - 200 degrees C temperature requirement. In that case, the coefficient of linear expansion of the ingredient of a flexible substrate serves as a value with desirable 1x10-6 to 10x10-6.
[0022] On the other hand, although polyimide was mentioned as most desirable thing from the point of thermal resistance or a mechanical strength as an ingredient of the flexible substrate used for a probe, polyimide with which it is satisfied of coefficient of linear expansion 1x10-6 to 10x10-6 as mentioned above was not used for the flexible substrate of the conventional probe.
[0023] In this invention, the configuration of polyimide should be consisted of the above-mentioned configuration unit (A) and (B), and those mole ratios were specified as (A):(B) =90:10-50:50. It has reinforcement sufficient as a flexible substrate of a probe, and moreover, coefficient of linear expansion is lower than the ingredient of the conventional flexible substrate, it becomes what is approximated to the coefficient of linear expansion of a silicon crystal, and the gap to the contacted section on a semiconductor device is controlled by this specification.
[0024] Moreover, when the ingredient of a flexible substrate was used as the above-mentioned polyimide and a conductive circuit was formed with common good conductors, such as copper, it found out curvature arising in a probe and becoming a new problem according to the difference of the coefficient of linear expansion between a flexible substrate and a conductive circuit. To such a problem, by using an iron nickel alloy for the ingredient of a conductive circuit, the difference of the coefficient of linear expansion between a flexible substrate and a conductive circuit becomes small, curvature is controlled, and a more desirable probe is obtained.
[0025]
[Embodiment of the Invention] First, the circuit board used for the probe of this invention is explained previously. The circuit board of this invention is the flexible circuit board by which the conductive circuit 3 was established in one [which has insulation] field 1a of the flexible substrate 1, as shown in drawing 3 R> 3.
[0026] As explanation of the above-mentioned operation described, when this circuit board is used as a probe, the difference of coefficient of linear expansion uses the ingredient of a flexible substrate as the ingredient which is 10x10 to six or less in 25 degrees C - 300 degrees C to that contact object. It is most desirable that it will be made from the polyimide explained below especially if contact objects are the electronic parts which have the coefficient of linear expansion of a silicon crystal.
[0027] Both the polyimide suitably used as an ingredient of the above-mentioned flexible substrate makes tetracarboxylic dianhydride and a specific diamino compound react in an organic polar solvent as start raw materials, and pass a polyimide precursor. Pyromellitic acid 2 anhydride (PMDA) is mentioned as the above-mentioned tetracarboxylic dianhydride. As the above-mentioned specific diamino compound, both m-tolidine and the diamino compound expressed with the following type (C) are used.
[0028]
[Formula 10]



(C)

[0029] X in the above-mentioned formula (C) is the same as that of X in the above-mentioned formula (B), i.e., the radical expressed with above-mentioned formula (i) - (v). The diamino compound expressed with the above-mentioned formula (C) has good thermal resistance.
[0030] The blending ratio of coal (X:Y) of a diamino compound (Y) expressed with the above-mentioned m-tolidine (X) and the above-mentioned formula (C) is a mole ratio, and it is desirable the range of X:Y=90:10-50:50 and to set it as the range of X:Y=85:15-60:40 especially. In the above-mentioned blending ratio of coal, if the value of the mole ratio of X exceeds 90, the reinforcement of a polyimide coat will fall. Conversely, if the value of the mole ratio of X becomes less than 50, the coefficient of linear expansion of the polyimide obtained will become large, and a base material will come to curl.
[0031] In addition, less than [of the amount of the diamino compound used / 15 mol %] which is expressed with the above-mentioned m-tolidine and the above-mentioned formula (C) may be replaced with other diamino compounds other than these diamino compounds. As other diamino compounds, for example P-phenylene

diamine, m-phenylenediamine, - diamino diphenyl ether, and 4 '3, 3'-diamino diphenyl ether, [3, and] - diamino diphenylmethane, and 4 and 4 '3, 3'-diaminodiphenyl sulfone, A 3 and 3'-diamino benzophenone, 1, 4-bis(4-amino phenoxy) benzene, - bis(4-amino phenoxy) diphenylsulfone, and 4 and 4'-bis(4-amino phenoxy) biphenyl, 4, and 4 '4, 4'-bis(3-amino phenoxy) diphenylsulfone etc. is mentioned.

[0032] Therefore, in this invention, the polyimide with which the whole ** consists of the above-mentioned configuration unit (A) and (B) or the ** above-mentioned configuration unit (A), and (B) are more than 85 mol % of the whole polyimide, and the polyimide suitably used as an ingredient of a flexible substrate is polyimide with which the remainder consists of a configuration unit formed of the reaction of PMDA and other diamino compounds.

[0033] The above-mentioned polyimide can compound and form a precursor as follows. That is, the above-mentioned tetracarboxylic dianhydride and the above-mentioned diamino compound are made to usually react at 0-90 degrees C into abbreviation equimolar and an organic polar solvent for 1 to 24 hours, and let them be a polyimide precursor. As the above-mentioned organic polar solvent, a N-methyl-2-pyrrolidone, N,N-dimethylacetamide, N.N-dimethylformamide, dimethyl sulfoxide, dimethyl phospho RUAMIDO, etc. are mentioned.

[0034] thus, the polyimide precursor compounded — the logarithm — it is desirable that viscosity (a N-methyl-2-pyrrolidone is used for a solvent, and it measures at the concentration of 0.5g / 100ml, and 30 degrees C) is in the range of 0.5-5.0. Since the mechanical strength of the polyimide which will be obtained if this value is smaller than 0.5 falls remarkably, it is not desirable. Conversely, since the spreading workability to a metallic foil will fall if this value is larger than 5.0, it is not desirable. a logarithm — viscosity etainh It is calculated by etainh = (ln (t1 / t0)) / C. However, the inside t1 of a formula and t0 It is the drop time amount measured by the capillary viscometer, and t1 is the drop time amount of a solution, and t0. It is the drop time amount of a solvent. C is the concentration expressed with more than in g of the polymer in 100ml of solutions. a logarithm — a viscosity number or the intrinsic viscosity calculated using it is connected with the molecular weight of a polymer.

[0035] A flexible substrate is manufactured as follows, using the organic polar-solvent solution of the polyimide precursor obtained as mentioned above.

[0036] (a) First, on the metallic foil which serves as a conductive circuit in the organic polar-solvent solution of the precursor of the above-mentioned polyimide, use well-known means, such as a roll coater and comma coater, and carry out flow casting spreading. As for the concentration of the polyimide precursor in an organic polar-solvent solution, it is desirable to set up to about 5 - 30% of the weight. If the front face of the polyimide which will be obtained if this concentration is lower than 5 % of the weight is too high to a dry area or the reverse which becomes empty, viscosity will become high and spreading workability will fall.

[0037] What is necessary is just to apply so that such thickness may be obtained since thickness with the desirable flexible substrate eventually obtained as polyimide is 8 micrometers - 50 micrometers although the spreading thickness of a precursor is not limited.

[0038] In order to raise the adhesive strength of the metallic foil used as a conductive circuit, and the polyimide which is a flexible substrate, it is desirable to process to begin sandblasting to the front face of a metallic foil, and to form corona discharge, chromate treatment or a silane coupling agent, and comparatively soft polyimide as a primer layer etc.

[0039] (b) After flow casting spreading of the above-mentioned solution to a metallic foil, heat-treat and form polyimide. This heat-treatment usually includes the process of 30 minutes - about 2 hours which carries out stoving and removes a solvent, and the process further heat-treated at the temperature of 250 degrees C - 600 degrees C for 1 minute to 3 hours at 100 degrees C - 230 degrees C.

[0040] The polyimide which consists of a configuration unit (A) expressed with the above-mentioned formula (A) and (B) and (B) is formed in a metallic foil front face of the process of the above (a) and (b), and the two-layer layered product of the metallic foil used as a conductive circuit and a flexible substrate is obtained.

[0041] This polyimide may be a block polymer by the configuration unit (A) and (B), may be a random polymer, or may be a mutual polymer. And the mole ratio of a structural unit (A) and a structural unit (B) must be set as the range of (A):(B) =90:10-50:50. Especially, the range of (A):(B) =85:15-60:40 is desirable. In the above-mentioned mole ratio, the reinforcement of a polyimide coat falls remarkably that the value of the mole ratio of a structural unit (A) exceeds 90 (if it says to reverse, the value of the mole ratio of a structural unit (B) is less than ten). Moreover, the coefficient of linear expansion of the polyimide obtained as the value of the mole ratio of a structural unit (A) is less than 50 becomes large, and when it uses for a probe and a big temperature change is given, big curvature will arise in the big gap and the probe itself to an inspection object (if it says to reverse and the value of the mole ratio of a structural unit (B) will exceed 50). moreover, the thing for which X in the above-

mentioned formula (B) showing a configuration unit (B) is chosen as mentioned above — the polyimide which was excellent in respect of thermal resistance and flexibility is obtained.
[0042] although you may be the good conductor metal use for common well-known circuit patterns, such as copper, nickel, a solder, gold, and silver, as an ingredient of the metallic foil used as a conductive circuit, when contact objects be the above-mentioned electronic parts, in a burn in test, the alloy of the point that not only gap but a curvature can be control to iron-nickel, and the iron nickel alloy (following "42 alloy") which contain nickel 42% of the weight especially be the most suitable.
[0043] Moreover, if only 42 alloys are used as a conductive circuit, depending on an application, that the resistance of the conductive circuit itself is high may pose a problem, but in that case, as shown in drawing 4 , it may consider as the conductive circuit which has the structure where the laminating of the conductor was carried out to multiplex, and the laminating of the layer 3b of the above-mentioned good conductor metal may be further carried out on conductive circuit 3a of 42 alloys formed on the flexible substrate 1. The mode 31 which carries out a laminating, the mode 32 which galvanizes a good conductor metal to the circuit pattern which consists of 42 alloys may perform the laminating of good conductor metal layer 3b to 42 alloy layer 3a in the process of which phase in the phase of a metallic foil item.
[0044] The thickness of the metallic foil used as a conductive circuit has 1 micrometer - desirable 500 micrometers, and 5 micrometers - its 50 micrometers are more desirable especially. In flexibility, since the whole probe which will be obtained if coating becomes difficult and exceeds 500 micrometers in order that there may be no reinforcement of a foil, when the thickness of a metallic foil is thinner than 1 micrometer becomes less suitable for the application of a chip and a probe, it is not desirable.
[0045] When manufacturing a probe using this circuit board, a conductive circuit is designed so that it may pass through directly under [of a flexible substrate / internal], the backs, or these near to the location of this contact surface, and is formed so that it may flow with the contact surface prepared on the field of a flexible substrate. Even if the mode of a conductive circuit is a circuit pattern, it may be the conductor layer which used the above-mentioned metallic foil, without processing it as it is. As an approach of forming a conductive circuit as a circuit pattern, although the well-known circuit pattern formation approaches, such as an additive process and a subtractive process, can be used, if it carries out from the production process of the flexible substrate concerned, the subtractive process which uses a metallic foil as a circuit pattern by etching etc. after formation of a flexible substrate is the most desirable.
[0046] Polyimide has very good dimensional stability, and even if the circuit board obtained as mentioned above is used for the burn in test to electronic parts etc. by using 42 alloys as an ingredient of a conductive circuit, it is equipped with the outstanding property that neither gap nor curvature occurs substantially.
[0047] Next, the probe of this invention is explained. Although it is desirable to form the above-mentioned circuit board first and to form using this as for the probe of this invention, the sequence of a process should just have the component of the above-mentioned circuit board eventually, such as not being limited, for example, completing a circuit pattern in the processing process of a probe.
[0048] Drawing 1 is the mimetic diagram showing an example of the fundamental structure of the probe by this invention. It is the structure where the contact surface 2 prepared in one [which has insulation] field 1a of the flexible substrate 1 in the example shown in this drawing, and the conductive circuit 3 established in field 1b of another side of this flexible substrate flowed. It is as having explained the flexible substrate and the conductive circuit in the above-mentioned circuit board.
[0049] A contact surface is prepared in the location corresponding to the contacted section of a contact object. The mode of the contact of the letter of a projection usually called the bump contact (or only bump) which consists of a good conductor metal that a contact surface should just be what can perform electric contact to the contacted section of a contact object is used. However, a bump contact does not necessarily need to project from a flexible substrate side, and may form the same field as a flexible substrate side, and a concave surface according to a partner's configuration. Moreover, a contact surface may be a mode (lead contact) which uses a part of conductive circuit as a contact surface. Hereafter, the case where a contact surface is used as a bump contact is explained.
[0050] As an ingredient of a bump contact, gold, silver, copper, lead, chromium, zinc, aluminum, nickel, iron, platinum, palladium, a rhodium, a ruthenium, etc. are illustrated, for example, and the configuration may carry out the laminating not only of a single metal kind but the different metal to the shape of a layer. When carrying out the laminating of the different metal to the shape of a layer, it is desirable to use things of Knoop hardness 700Hk-1200Hk, such as a rhodium and a ruthenium, as a metal of the outermost surface.

[0051] Although a bump contact is formed so that it may flow with a conductive circuit, the structure which flows through the breakthrough which was formed in the location (relation it is just under related mutually) which corresponds to drawing 1 mutually in the table / flesh side or the front face / depths of a flexible substrate so that it may be shown, and was prepared in the flexible substrate is desirable structure. The formation approach of a bump contact of having the structure of such a flow is roughly explained below as an example using the circuit board for the above-mentioned probes.
[0052] first, the location (location which corresponds right above when said conductive circuit is located in the interior of a substrate) which is equivalent to the back of the conductive circuit 3 in field 1a of the flexible substrate 1 as shown in drawing 1 -- a breakthrough 5 -- preparing -- the hole -- the conductive circuit 3 of rear-face 1b is exposed on an inside base. With the electrolysis plating which uses as a negative electrode next the field of the conductive circuit exposed to the base in a hole, in a breakthrough, the good conductor metal used as the ingredient of a bump contact is deposited, it is filled up, a deposit is continued further, a good conductor metal is projected from the front face of a flexible substrate, and a bump contact 2 is obtained.
[0053] The approach of covering the conductive circuit formed on the flexible substrate with the ingredient which has flexibility and insulation further as an approach of establishing a conductive circuit in the interior of a flexible substrate is mentioned. In this case, although the ingredient used for a coat differs from each other even if it is the same as the ingredient of a flexible substrate, considering as both the above-mentioned polyimide is more desirable.
[0054] The dry etching method using laser, such as wet etching which etches into a flexible substrate chemically, using a chemical, a solvent, etc. as an approach of forming a breakthrough, carbon dioxide gas, YAG, and an excimer, or the plasma can be used. When performing detailed hole processing especially, it is desirable to use the etching method which used laser.
[0055] Other examples of structure of the probe of this invention are typically shown in drawing 2 (a) and (b). Although drawing 2 (a) is the same configuration as drawing 1 , it has the structure where the conductive circuit was established in the interior of a flexible substrate, by covering the whole surface of the conductive circuit 3 with the enveloping layer 4 which consists of the same ingredient as the flexible substrate 1. B is a contact object. drawing 2 (b) -- the conductor of a conductive circuit -- it is the example of structure using the very thing as a contact selectively. Moreover, the contact object B is a bare chip and the contacted section B1 is an example in the case of a pewter bump contact. In the example of this drawing, the conductive circuit 3 is exposed selectively, it considers as the contact surface 2 of the letter of a lead, and the contact surface 2 by the side of a probe is made into the detailed and flat contact surface to the contacted section B1 of the letter of a projection.
[0056]
[Example] Hereafter, an example is given and this invention is explained more concretely. First, the example of manufacture of the circuit board for probes by this invention is shown in the following examples 1-4, and the example of manufacture of the probe using them is shown in examples 5 and 6. however, the logarithm shown in the following -- like the above, viscosity uses a N-methyl-2-pyrrolidone for a solvent, and measures it at the concentration of 0.5g / 100ml, and 30 degrees C. Moreover, the solution viscosity of a polyimide precursor is measured at 30 degrees C using a Brookfield viscometer.
[0057] In example 1 this example, the radical X especially contained in a structural unit (B) was made into the radical expressed with the above-mentioned formula (i) using the polyimide which consists of a structural unit (A) expressed with the above-mentioned formula (A) and (B), and (B) as an ingredient of a flexible substrate.
[0058] First, m-tolidine (TLD)g [17.0] and 4 and 4'-diamino phenyl ether (DDE) 4.0g and 172g (NMP) of N-methyl-2-pyrrolidones were put in and stirred to the separable flask with an equipped with the agitator and the thermometer volume of 500 cc, and said diamino compound was dissolved in it.
[0059] Next, in addition, stirring was continued at the temperature of 30 degrees C or less after that for 5 hours gradually [21.8g (PMDA) of pyromellitic acid 2 anhydrides] to this, and the polyimide precursor solution of 20% of concentration was obtained. the logarithm of this polyimide precursor solution -- viscosity was 1.90 and solution viscosity was 800 Pa-s.
[0060] The obtained solution was diluted with NMP so that it might become a polyimide precursor solution 15%, on 42 alloy foil with a thickness of 20 micrometers, the applicator was used, flow casting spreading was carried out, under nitrogen-gas-atmosphere mind, it performed at 200 degrees C for 30 minutes for 30 minutes, 400 more degrees C performed heating of 1 hour at 100 degrees C, and the flexible substrate was produced. The thickness of a flexible substrate was 45 micrometers.

[0061] This polyimide became a structural unit (A) from (B), and these mole ratios were (A):(B) =80:20. Moreover, the coefficient of linear expansion of the direction of a field as a layered product including 42 alloy foil was 3.0x10-6.
[0062] Next, coating of the photoresist was carried out to the front face of 42 alloy foil, by exposure, development, etching, and resist exfoliation, the predetermined circuit pattern (conductive circuit) designed so that the back of the predetermined location which should form a bump contact might be passed was formed, and the circuit board for probes by this invention was obtained.
[0063] Although the polyimide which consists of a structural unit (A) and (B) as an ingredient of a flexible substrate was used like the above-mentioned example 1 in example 2 this example, the radical X contained in a structural unit (B) was made into the radical expressed with the above-mentioned formula (iv).
[0064] First, TLDg [18.0] and 2 and 2-screw [4-(4-amino phenoxy) phenyl] propane 6.2g and NMP184g were put in and stirred to the same separable flask as an example 1, and said diamino compound was dissolved in it. Next, PMDA21.8g was gradually added to this, stirring was continued at the temperature of 30 degrees C or less after that for 5 hours, and the polyimide precursor solution of 20% of concentration was obtained. the logarithm of this polyimide precursor solution -- viscosity was 2.05 and solution viscosity was 950 Pa-s.
[0065] The flexible substrate with a thickness of 38 micrometers was produced at the completely same process as the above-mentioned example 1 using the obtained polyimide precursor solution and 42 alloy foil with a thickness of 35 micrometers. This polyimide became a structural unit (A) from (B), and these mole ratios were (A):(B) =85:15. Moreover, the coefficient of linear expansion of the direction of a field as a flexible substrate was 3.3x10-6.
[0066] Next, completely like the above-mentioned example 1, 42 alloy foil was processed as a circuit pattern (conductive circuit), and the circuit board for probes by this invention was obtained.
[0067] Although the polyimide which consists of a structural unit (A) and (B) as an ingredient of a flexible substrate was used like the above-mentioned example 1 in example 3 this example, the radical X contained in a structural unit (B) was made into the radical expressed with the above-mentioned formula (v).
[0068] TLDg [19.1] and 2 and 2-screw [4-(amino phenoxy) phenyl] hexafluoropropane 5.2g and NMP184.4g were put in and stirred to the same separable flask as an example 1, and said diamino compound was dissolved in it. Next, PMDA21.8g was gradually added to this, stirring was continued at the temperature of 30 degrees C or less after that for 5 hours, and the polyimide precursor solution of 20% of concentration was obtained. the logarithm of this polyimide precursor solution -- viscosity was 1.85 and solution viscosity was 840 Pa-s.
[0069] The obtained polyimide precursor solution was diluted with NMP to 15%, on 42 alloy foil with a thickness of 35 micrometers, the applicator was used, flow casting spreading was carried out, under nitrogen-gas-atmosphere mind, it performed at 200 degrees C for 30 minutes for 30 minutes, 400 more degrees C performed heating of 1 hour at 100 degrees C, and the flexible substrate with a thickness of 60 micrometers was produced.
[0070] This polyimide consisted of a structural unit (A) and a structural unit (B), and these mole ratios were (A):(B) =90:10. Moreover, the coefficient of linear expansion of the direction of a field as a flexible substrate was 3.4x10-6.
[0071] Next, completely like the above-mentioned example 1, 42 alloy foil was processed as a circuit pattern (conductive circuit), and the circuit board for probes by this invention was obtained.
[0072] Although the radical X contained in a structural unit (A), (B), and a structural unit (B) was the same as that of the above-mentioned example 1 altogether as an ingredient of a flexible substrate at example 4 this example, the mole ratio of a structural unit (A) and a structural unit (B) used the polyimide which is (A):(B) =50:50.
[0073] First, TLDg [10.6] and 4 and 4'-diamino diphenyl ether 10.0g and NMP168.8g were put in and stirred to the same separable flask as an example 1, and the above-mentioned diamino compound was dissolved in it. Next, PMDA21.8g was gradually added to this, stirring was continued at the temperature of 30 degrees C or less after that for 5 hours, and the polyimide precursor solution of 20% of concentration was obtained. the logarithm of this polyimide precursor solution -- viscosity was 1.80 and solution viscosity was 720 Pa-s.
[0074] The flexible substrate with a thickness of 60 micrometers was produced at the completely same process as the above-mentioned example 1 using the obtained polyimide precursor solution and 42 alloy foil with a thickness of 35 micrometers. This polyimide became a structural unit (A) from (B), and these mole ratios were (A):(B) =50:50. Moreover, the coefficient of linear expansion of the direction of a field as a flexible substrate was 6.5x10-6.
[0075] Next, completely like the above-mentioned example 1, 42 alloy foil was processed as a circuit pattern

(conductive circuit), and the circuit board for probes by this invention was obtained.
[0076] Using the circuit board for probes produced in the example 5 above-mentioned examples 1-4, the bump contact was formed in these each and the probe of the structure shown in drawing 1 was produced a total of four kinds. The formation process of a bump contact is shown below.
[0077] First, in the circuit board for probes, with the field in which the conductive circuit was formed among both sides of a flexible substrate, carbon dioxide laser was irradiated by the mask projection + gal BANOSU can method to the field of an opposite hand in the location which should form a bump contact, the breakthrough with a bore of 80 micrometers was formed, and the conductive circuit was exposed on the internal base of this breakthrough. On next, the front face (except for the part exposed to the internal base of a breakthrough) of a conductive circuit After depositing nickel and filling up with electroplating which uses a conductive circuit as a negative electrode after giving the resist film to plating in a breakthrough, a deposit is continued further. The bump contact whose projection height from a substrate side is 20 micrometers was formed, it plated with gold by the thickness of 1 micrometer on the front face further, the rhodium plate was performed by the thickness of 1 more micrometer, the resist film was exfoliated, and the probe by this invention was obtained.
[0078] After sticking the 6 inch wafer to four kinds of probes obtained by this example as a contact object and applying to a burn-in cycle with a room temperature of 25 degrees C - 150 degrees C, when the front face of each contact section of a wafer and a probe was observed, the big marks by a gap of a bump contact or point of contact of which wafer were not generated, and the damage was not seen on the bump contact front face by the side of a probe, either. Moreover, there was no curvature which poses an activity top problem in the probe itself.

[0079] In example 6 this example, to the circuit board for probes produced in the above-mentioned examples 1-4, the conductive circuit was further covered with polyimide, and it considered as the structure where the conductive circuit was established in the interior of a flexible substrate, and considered as the probe of the structure which prepares a bump contact in this and is shown in drawing 2 (a).
[0080] Completely like examples 1-4, after forming a conductive circuit to one field of a flexible substrate, except for the part used for connection with an external measuring machine machine, the cover coat of this conductive circuit was further carried out by the enveloping layer 4 which consists of the same polyimide as the ingredient of each flexible substrate.
[0081] With the field in which the conductive circuit was formed among both sides of a flexible substrate, to the field of an opposite hand, the excimer laser with a wavelength of 248nm was irradiated in mask projection, the breakthrough with a bore of 30 micrometers was formed in the location which should form a bump contact, and the conductive circuit was exposed on the base of this breakthrough. After giving the resist film to plating to the external connection terminal area of a conductive circuit, After depositing nickel and filling up with electroplating which uses a conductive circuit as a negative electrode in a breakthrough, a deposit is continued further. The bump contact whose projection height from a substrate side is 25 micrometers was formed, it plated with gold by the thickness of 1 micrometer on the front face further, the rhodium plate was performed by the thickness of 1 more micrometer, the resist film was exfoliated, and the probe by this invention was obtained.
[0082] After sticking the bare chip to four kinds of probes obtained by this example as a contact object and applying to a burn-in cycle with a room temperature of 25 degrees C - 125 degrees C, when the front face of each contact section of a bare chip and a probe was observed, the big marks by a gap of a bump contact or point of contact of which bare chip were not generated, and the damage was not seen on the bump contact front face by the side of a probe, either. Moreover, there was no curvature which poses an activity top problem in the probe itself.
[0083] In the example of the one example comparison of a comparison, the circuit board for probes was produced using the polyimide with which a configuration unit differs from the polyimide used by this invention as an ingredient of a flexible substrate. First, TLD21.2g and NMP172g were put in and stirred to the same separable flask as an example 1, and said diamine was dissolved in it. Next, PMDA21.8g was gradually added to this, stirring was continued at the temperature of 30 degrees C or less after that for 5 hours, and the polyimide precursor solution of 20% of concentration was obtained. the logarithm of this polyimide precursor solution — viscosity was 1.85 and solution viscosity was 750 Pa-s.
[0084] The flexible substrate with a thickness of 33 micrometers was produced at the same process as an example 1 using the obtained polyimide precursor solution and 42 alloy foil with a thickness of 20 micrometers. This flexible substrate was not the thing of the quality level which carried out 42 alloy foil side inside, has already curled greatly when the above-mentioned making process is completed, and can be used for probe manufacture

as the circuit board. Moreover, the coefficient of linear expansion of the direction of a field as a flexible substrate was -6.0x10-6.

[0085] The polyimide used by this invention produced the circuit board for probes as an ingredient of a flexible substrate like the example 1 of example of comparison 2 comparison using the polyimide with which configuration units differ. First, 4 and 4'-diamino diphenyl ether (DDE) 20g and NMP168g were put in and stirred to the same separable flask as an example 1, and said diamine was dissolved in it. Next, PMDA21.8g was gradually added to this, stirring was continued at the temperature of 30 degrees C or less for 5 hours, and the polyimide precursor solution of 20% of concentration was obtained. the logarithm of this polyimide precursor solution — viscosity was 2.20 and solution viscosity was 1000 Pa-s.

[0086] The flexible substrate with a thickness of 40 micrometers was produced at the same process as an example 1 using the obtained polyimide precursor solution and 42 alloy foil with a thickness of 15 micrometers. This flexible substrate was not the thing of the quality level which carries out 42 alloy side inside, curls greatly, and can already be used for manufacture of a probe as the circuit board like the case of the example 1 of a comparison when the above-mentioned making process is completed. Moreover, the coefficient of linear expansion of the direction of a field as a flexible substrate was 32.5x10-6.

[0087] In the example of the three example comparison of a comparison, as an ingredient of a flexible substrate, although the structural unit was the same as that of this invention (example 2), the mole ratio of a structural unit (A) and a structural unit (B) produced the flexible substrate using the polyimide out of range shown by this invention. First, TLDg [20.1] and 2 and 2-screw [4-(4-amino phenoxy) phenyl] propane 2.1g and NMP175.2g were put in and stirred to the same separable flask as an example 1, and said diamino compound was dissolved in it. Next, PMDA21.8g was gradually added to this, stirring was continued at the temperature of 30 degrees C or less for 5 hours, and the polyimide precursor solution of 20% of concentration was obtained. the logarithm of this polyimide precursor solution — viscosity was 1.85 and solution viscosity was 830 Pa-s.

[0088] The flexible substrate with a thickness of 60 micrometers was produced at the same process as an example 1 using the obtained polyimide precursor solution and 42 alloy foil with a thickness of 35 micrometers. Although the structural unit of the polyimide which forms a flexible substrate was the same as that of an example 2, the structural unit (A) and the mole ratio with (B) were (A):(B) =95:5. Moreover, the coefficient of linear expansion of the direction of a field as a flexible substrate was -1.0x10-6. The obtained polyimide was not what there is no flexibility and can be used as a flexible substrate also in reinforcement.

[0089] Like the example 3 of a comparison, as an ingredient of a flexible substrate, although the structural unit was the same as that of this invention (example 2), in the example of the four example comparison of a comparison, the mole ratio of a structural unit (A) and a structural unit (B) produced the flexible substrate using the polyimide out of range shown by this invention. First, TLDg [9.5] and 2 and 2-screw [4-(4-amino phenoxy) phenyl] propane 22.6g and NMP214.8g were put in and stirred to the same separable flask as an example 1, and said diamino compound was dissolved in it. Next, PMDA21.8g was gradually added to this, stirring was continued at the temperature of 30 degrees C or less after that for 5 hours, and the polyimide precursor solution of 20% of concentration was obtained. the logarithm of this polyimide precursor solution — viscosity was 2.05 and solution viscosity was 950 Pa-s.

[0090] The flexible substrate with a thickness of 60 micrometers was produced at the same process as an example 1 using the obtained polyimide precursor solution and 42 alloy foil with a thickness of 35 micrometers. Although the structural unit of the polyimide which forms this flexible substrate was the same as that of an example 2, the structural unit (A) and the mole ratio with (B) were (A):(B) =45:55. Moreover, the coefficient of linear expansion of the direction of a field as a flexible substrate was 12.0x10-6.

[0091] Next, completely like the above-mentioned example 1, 42 alloy foil was processed as a circuit pattern (conductive circuit), and the probe was produced at the still more nearly same process as an example 5.

[0092] After sticking the bare chip to the probe obtained in this example of a comparison as a contact object and applying to a burn-in cycle with a room temperature of 25 degrees C - 150 degrees C, when the front face of each contact section of a bare chip and a probe was observed, in the pad section of a bare chip, the crack by which the bump contact moved over dozens of micrometers had occurred.

[0093]

[Effect of the Invention] Even if it is exposed to intense temperature changes, such as a burn in test, when the probe of this invention is used as for example, a checking probe so that clearly also from the result of the above-mentioned explanation and an example, it is hard to generate curvature in a probe, and the dimensional stability which was moreover excellent is shown in it. By this, there is also little gap with a bump contact and the

contacted section, and contact dependability and its endurance as test equipment also improve. Moreover, also when it uses as a splicer for mounting, the dependability of the connection which was excellent also under the operating environment on which an intense temperature change acts is shown.

[Translation done.]

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3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the mimetic diagram showing an example of the fundamental structure of the probe by this invention.
[Drawing 2] It is the mimetic diagram showing other examples of structure of the probe by this invention.
[Drawing 3] It is the mimetic diagram showing an example of the structure of the circuit board used for the probe of this invention.
[Drawing 4] It is the mimetic diagram showing the example of structure of the conductive circuit in the circuit board of this invention.
[Description of Notations]
1 Flexible Substrate
2 Contact Surface
3 Conductive Circuit (Circuit Pattern)

[Translation done.]

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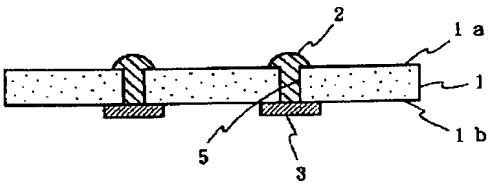
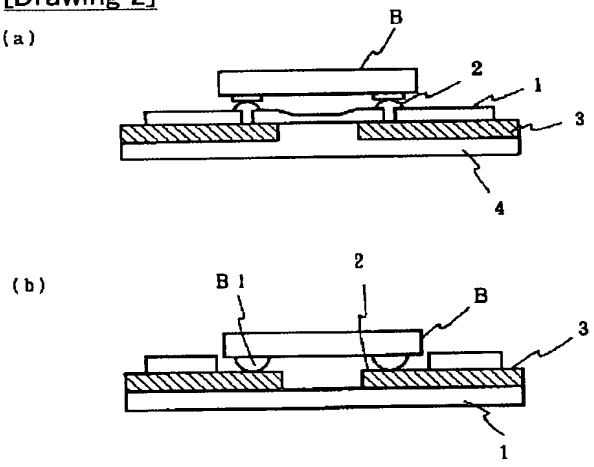
DRAWINGS

[Drawing 1]

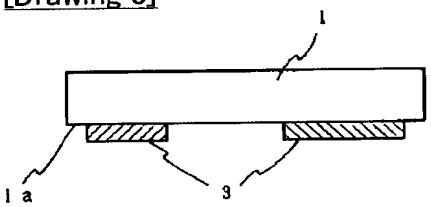


1 フレキシブル基板
2 接点部
3 導電性回路

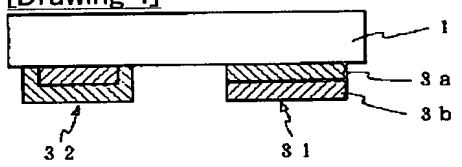
[Drawing 2]



[Drawing 3]



[Drawing 4]



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Ｈ０１Ｒ　33/76			Ｈ０１Ｒ　33/76		

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(71)出願人　000003964
日東電工株式会社
大阪府茨木市下穂積１丁目１番２号

(72)発明者　東　一美
大阪府茨木市下穂積１丁目１番２号　日東電工株式会社内

(72)発明者　日野　敦司
大阪府茨木市下穂積１丁目１番２号　日東電工株式会社内

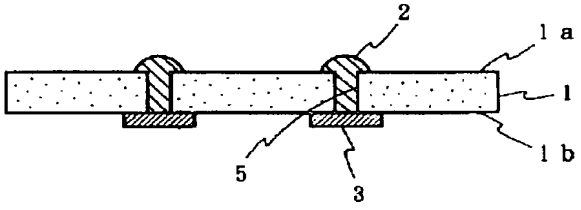
(74)代理人　弁理士　高島　一

(54)【発明の名称】　プローブおよびプローブ用回路基板

(57)【要約】

【課題】　バーンイン試験等における高温での使用条件下においても、優れた接触信頼性をもって接触対象物に接触でき、検査用としても優れた耐久性を有するプローブおよびこれを製造するための部材である回路基板を提供すること。

【解決手段】　絶縁性を有するフレキシブル基板１の一方の面１ａに設けられた接点部２と、該フレキシブル基板のいずれかの面または内部に設けられた導電性回路３とが導通された構造のプローブにおいて、フレキシブル基板の材料の線膨張係数と、当該プローブの接触対象物の線膨張係数との差を、２５℃～３００℃において１０×１０$^{-6}$以下とする。



1　フレキシブル基板

2　接点部

3　導電性回路

1

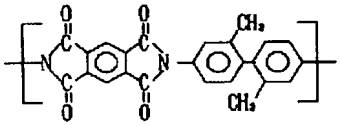
【特許請求の範囲】

【請求項１】　絶縁性を有するフレキシブル基板の一方の面に設けられた接点部と、該フレキシブル基板のいずれかの面または内部に設けられた導電性回路とが導通された構造を有し、前記フレキシブル基板の材料の線膨張係数と、当該プローブの接触対象物の線膨張係数との差が、２５℃～３００℃において１０×１０$^{-6}$以下であることを特徴とするプローブ。

【請求項２】　当該プローブの接触対象物がシリコン結晶の線膨張係数を有する電子部品であって、上記フレキシブル基板の材料の線膨張係数が１×１０$^{-6}$～１０×１０$^{-6}$である請求項１記載のプローブ。

【請求項３】　フレキシブル基板の材料が、式（Ａ）：

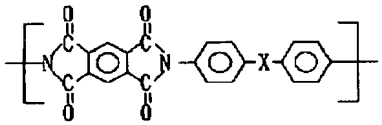
【化１】



（Ａ）

で表される構造単位（Ａ）と、式（Ｂ）：

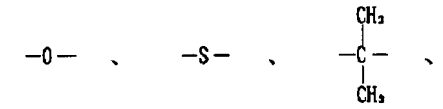
【化２】

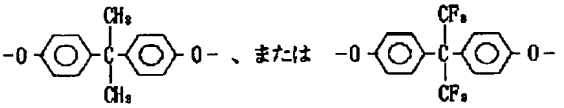


（Ｂ）

（式中、Ｘは、

【化３】





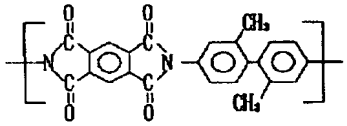
で表される基を示す）で表される構造単位（Ｂ）とからなり、構造単位（Ａ）と構造単位（Ｂ）とのモル比が（Ａ）：（Ｂ）＝９０：１０～５０：５０のポリイミドである請求項２記載のプローブ。

【請求項４】　導電性回路が、鉄－ニッケル合金によって形成された回路であるか、または、フレキシブル基板側の鉄－ニッケル合金からなる層と表層側の良導体金属からなる層とが積層された構造の回路である請求項１記載のプローブ。

【請求項５】　絶縁性を有するフレキシブル基板の一方の面に導電性回路が設けられ、フレキシブル基板の材料が、式（Ａ）：

2

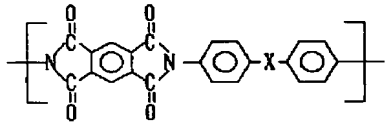
【化４】



（Ａ）

で表される構造単位（Ａ）と、式（Ｂ）：

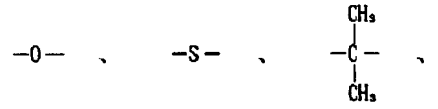
【化５】

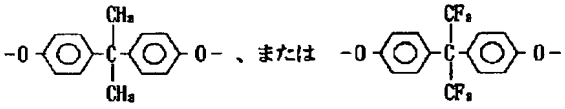


（Ｂ）

（式中、Ｘは、

【化６】





で表される基を示す）で表される構造単位（Ｂ）とからなり、構造単位（Ａ）と構造単位（Ｂ）とのモル比が（Ａ）：（Ｂ）＝９０：１０～５０：５０のポリイミドであって、導電性回路が、鉄－ニッケル合金によって形成された回路であるかまたはフレキシブル基板側の鉄－ニッケル合金からなる層と表層側の良導体金属からなる層とが積層された構造の回路であることを特徴とするプローブ用回路基板。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、集積回路などの微細な接触対象物に対して電気的な接触を行なうプローブに関する。

【０００２】

【従来の技術】近年の電子機器の小型化、薄型化に伴って、そこに搭載されるＩＣなどの半導体装置もますますの小型化が要求され、半導体素子の実装面積も極限にまで小さくすることが要求されてきている。こうした要求への回答の一つとして、シリコンウエハ上に多数形成された段階や分断された段階の半導体素子（以下、分断された段階のものをベアチップと呼ぶ）を、パッケージせず、そのままで基板に実装するベアチップ実装が行われており、今後この実装形態への移行が急速に進んでいくと考えられている。また、将来はウエハ状態のままでの実装さえも行われようとしている。従って、半導体素子

に対する種々の品質測定、試験、特に半導体素子にとって厳しい高温の条件下において行われるバーンイン試験も、ベアチップ、あるいはその前段階であるウエハの状態で行わなければならない。

【０００３】上記ベアチップやウエハ等の接触対象物上に形成された微細な電極や導体部分等の被接触部に対して、電気的な接触を行なうにはプローブが用いられる。本発明でいうプローブは、針式などのメカニカルな機構を有するプローブとは異なる面状のプローブである。その構造は、絶縁性を有するフレキシブル基板の一方の面に設けられた接点部と、該フレキシブル基板のいずれかの面または内部に設けられた導電性回路とが導通された構造が一般的である。プローブの接点部は、被接触部に対して電気的な接触を行う部分であって、通常はバンプ接点（または単にバンプ）と呼ばれる突起状の良導体金属接点である。

【０００４】

【発明が解決しようとする課題】従来、プローブを接触対象物に接触させた状態で、大きな温度変化を与えた場合に、接触対象物の線膨張係数とプローブの線膨張係数との差が問題になる場合がある。特に、検査用プローブとしてベアチップのバーンイン試験を行なう場合には、プローブをベアチップに接触させた状態で、通常１２０℃～１５０℃程度、場合によっては２００℃程度の高温にまで加熱される。このような場合、従来のプローブでは、該プローブの線膨張係数と接触対象物の線膨張係数とが互いに大きく異なるために、試験開始時の室温状態では接触対象物上の被接触部に接触していたプローブの接点部が、温度上昇後には相手の被接触部からずれてはみ出し、接触不良や検査不能となるという問題があった。

【０００５】また、プローブの接点部が被接触部からずれてはみ出す程までには至らなくとも、プローブの接点部が被接触部に接触した状態のまま数十μｍの長さにわたってずれることによって、接触対象物の被接触部が大きく傷つけられ、製品としての品質が大きく低下するという問題や、逆にプローブの接点部が被接触部によって傷つけられ、検査装置としての耐久性が低下するという問題があった。

【０００６】本発明の課題は、上記問題を解決し、バーンイン試験等における高温での使用条件下においても、優れた接触信頼性をもって接触対象物に接触でき、検査用としても優れた耐久性を有するプローブおよびこれを製造するための部材である回路基板を提供することである。

【０００７】

【課題を解決するための手段】本発明者らは、リジッド基板などを用いてフレキシブル基板の熱膨張を抑制するのではなく、フレキシブル基板自体の線膨張係数を接触対象物の線膨張係数により近づけることに着目し、本発明を完成させた。特に、接触対象物がシリコン結晶を基板とするような半導体素子である場合には、フレキシブル基板の材料として最適なポリイミドの特定を行った。また、フレキシブル基板の材料として最適なポリイミドの特定を行った場合に、フレキシブル基板と導電性回路の線膨張係数の差によって、回路基板・プローブ全体に新たに発生する反りをさらなる問題とし、これを解決して、本発明の有用性をより高めた。

【０００８】本発明のプローブおよび回路基板は、次の特徴を有するものである。

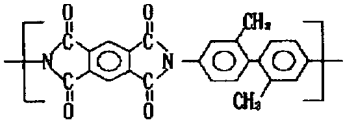
（１）絶縁性を有するフレキシブル基板の一方の面に設けられた接点部と、該フレキシブル基板のいずれかの面または内部に設けられた導電性回路とが導通された構造を有し、前記フレキシブル基板の材料の線膨張係数と、当該プローブの接触対象物の線膨張係数との差が、２５℃～３００℃において１０×１０$^{-6}$以下であることを特徴とするプローブ。

【０００９】（２）当該プローブの接触対象物がシリコン結晶の線膨張係数を有する電子部品であって、上記フレキシブル基板の材料の線膨張係数が１×１０$^{-6}$～１０×１０$^{-6}$である上記（１）記載のプローブ。

【００１０】（３）フレキシブル基板の材料が、式（Ａ）：

【００１１】

【化７】

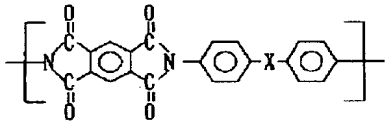


(A)

【００１２】で表される構造単位（Ａ）と、式（Ｂ）：

【００１３】

【化８】



(B)

【００１４】（式中、Ｘは、下式（ｉ）～（ｖ）：

【００１５】

【化９】

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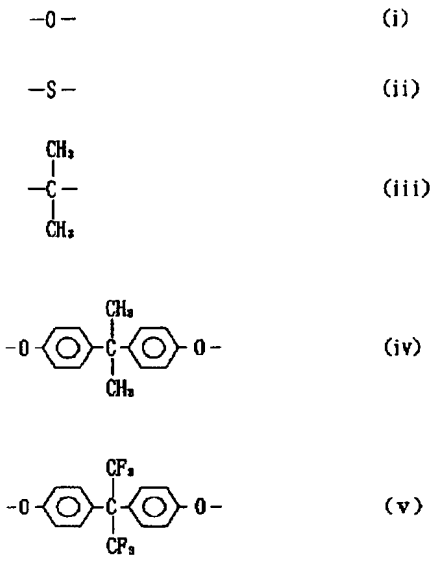

(i)　(ii)　(iii)　(iv)　(v)

【００１６】で表される基（ｉ）～（ｖ）から選ばれる１つの基を示す）で表される構造単位（Ｂ）とからなり、構造単位（Ａ）と構造単位（Ｂ）とのモル比が（Ａ）：（Ｂ）＝９０：１０～５０：５０のポリイミドである上記（２）記載のプローブ。

【００１７】（４）導電性回路が、鉄－ニッケル合金によって形成された回路であるか、または、フレキシブル基板側の鉄－ニッケル合金からなる層と表層側の良導体金属からなる層とが積層された構造の回路である上記（１）記載のプローブ。

【００１８】（５）絶縁性を有するフレキシブル基板の一方の面に導電性回路が設けられ、フレキシブル基板の材料が、上記（３）に記載のポリイミドであって、導電性回路が、上記（４）に記載の導電性回路であることを特徴とするプローブ用回路基板。

【００１９】本発明のプローブは、検査用プローブのように接触対象物に対して一時的に接触を行なうものだけでなく、ベアチップなどの実装用として接触対象物に対して永久的に接触させたままで用いられる接続手段をも含むものである。

【００２０】

【作用】フレキシブル基板の材料の線膨張係数と、当該プローブの接触対象物の線膨張係数との差を、２５℃～３００℃において１０×１０$^{-6}$以下とすることによって、検査用プローブとして用い、バーンイン試験のような室温から高温までの温度変化にさらされても、プローブの接点部と、接触対象物の被接触部とのずれを好適に抑制することができる。

【００２１】特に、接触対象物が、半導体素子・集積回路などのベアチップやウエハなど、微細な被接触部を有する電子部品である場合には、これらの線膨張係数は、結晶基板として用いられるシリコン結晶の線膨張係数と同等であると見てよく、その値は、０℃～２００℃の温

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度範囲においては、３．５×１０$^{-6}$程度である。その場合、フレキシブル基板の材料の線膨張係数は、１×１０$^{-6}$～１０×１０$^{-6}$が好ましい値となる。

【００２２】一方、プローブに用いられるフレキシブル基板の材料としては、耐熱性や機械的強度の点からポリイミドが最も好ましいものとして挙げられるが、上記のように線膨張係数１×１０$^{-6}$～１０×１０$^{-6}$を満足するようなポリイミドは、従来のプローブのフレキシブル基板には用いられてはいなかった。

【００２３】本発明では、ポリイミドの構成を上記構成単位（Ａ）、（Ｂ）からなるものとし、それらのモル比を（Ａ）：（Ｂ）＝９０：１０～５０：５０に特定した。この特定によって、プローブのフレキシブル基板として充分な強度を有し、しかも従来のフレキシブル基板の材料よりも線膨張係数が低く、シリコン結晶の線膨張係数に近似するものとなって、半導体素子上の被接触部に対するずれが抑制される。

【００２４】また、フレキシブル基板の材料を上記ポリイミドとしたとき、導電性回路を銅などの一般的な良導体によって形成した場合には、フレキシブル基板と導電性回路との間の線膨張係数の差によって、プローブに反りが生じ、新たな問題となることを見いだした。このような問題に対しては、導電性回路の材料に、鉄－ニッケル合金を用いることによって、フレキシブル基板と導電性回路との間の線膨張係数の差が小さくなり、反りが抑制され、より好ましいプローブが得られる。

【００２５】

【発明の実施の形態】先ず、本発明のプローブに用いられる回路基板を先に説明する。本発明の回路基板は、図３に示すように、絶縁性を有するフレキシブル基板１の一方の面１ａに導電性回路３が設けられたフレキシブル回路基板である。

【００２６】フレキシブル基板の材料は、上記作用の説明で述べたように、この回路基板をプローブとして用いたとき、その接触対象物に対して、線膨張係数の差が２５℃～３００℃において１０×１０$^{-6}$以下であるような材料とする。特に、接触対象物が、シリコン結晶の線膨張係数を有する電子部品であるならば、次に説明するポリイミドを材料とすることが最も好ましい。

【００２７】上記フレキシブル基板の材料として好適に用いられるポリイミドは、テトラカルボン酸二無水物と、特定のジアミノ化合物とを、共に出発原料として、有機極性溶媒中で反応させ、ポリイミド前駆体を経て得られる。上記テトラカルボン酸二無水物としては、ピロメリット酸二無水物（ＰＭＤＡ）が挙げられる。上記特定のジアミノ化合物としては、ｍ－トリジンと、下記式（Ｃ）で表されるジアミノ化合物とが共に用いられる。

【００２８】

【化１０】

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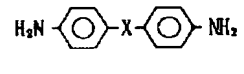 　　(C)

【００２９】上記式（Ｃ）におけるＸは、上記式（Ｂ）におけるＸ、即ち、上記式（ｉ）～（ｖ）で表される基と同様である。上記式（Ｃ）で表されるジアミノ化合物は、耐熱性が良好である。

【００３０】上記ｍ－トリジン（Ｘ）および上記式（Ｃ）で表されるジアミノ化合物（Ｙ）の配合割合（Ｘ：Ｙ）は、モル比で、Ｘ：Ｙ＝９０：１０～５０：５０の範囲、特に、Ｘ：Ｙ＝８５：１５～６０：４０の範囲に設定することが好ましい。上記配合割合において、Ｘのモル比の値が９０を越えると、ポリイミド皮膜の強度が低下する。逆にＸのモル比の値が５０未満となると、得られるポリイミドの線膨張係数が大きくなり、基材がカールするようになる。

【００３１】尚、上記ｍ－トリジンおよび上記式（Ｃ）で表されるジアミノ化合物の使用量の１５モル％以内を、これらのジアミノ化合物以外の他のジアミノ化合物で置き換えても良い。他のジアミノ化合物としては、例えばｐ－フェニレンジアミン、ｍ－フェニレンジアミン、３，４’－ジアミノジフェニルエーテル、３，３’－ジアミノジフェニルエーテル、４，４’－ジアミノジフェニルメタン、３，３’－ジアミノジフェニルスルホン、３，３’－ジアミノベンゾフェノン、１，４－ビス（４－アミノフェノキシ）ベンゼン、４，４’－ビス（４－アミノフェノキシ）ビフェニル、４，４’－ビス（４－アミノフェノキシ）ジフェニルスルホン、４，４’－ビス（３－アミノフェノキシ）ジフェニルスルホンなどが挙げられる。

【００３２】従って、本発明において、フレキシブル基板の材料として好適に用いられるポリイミドは、①全体が上記構成単位（Ａ）、（Ｂ）だけからなるポリイミド、または、②上記構成単位（Ａ）、（Ｂ）がポリイミド全体の８５モル％以上であって、残りが、ＰＭＤＡと他のジアミノ化合物との反応により形成された構成単位からなるポリイミドである。

【００３３】上記ポリイミドは次のように前駆体を合成して形成することができる。即ち、上記テトラカルボン酸二無水物と、上記ジアミノ化合物を、略等モル、有機極性溶媒中において、通常０～９０℃で１～２４時間反応させ、ポリイミド前駆体とする。上記の有機極性溶媒としては、Ｎ－メチル－２－ピロリドン、Ｎ，Ｎ－ジメチルアセトアミド、Ｎ，Ｎ－ジメチルホルムアミド、ジメチルスルホキシド、ジメチルホスホルアミド等が挙げられる。

【００３４】このようにして合成されるポリイミド前駆体は、その対数粘度（溶媒にＮ－メチル－２－ピロリドンを用い、濃度０．５ｇ／１００ｍｌ、３０℃で測定）が０．５～５．０の範囲にあるのが好ましい。この値が０．５より小さいと得られるポリイミドの機械的強度が

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著しく低下するので好ましくない。逆にこの値が５．０より大きいと金属箔への塗布作業性が低下するので好ましくない。対数粘度η_{inh}は、η_{inh}＝（ｌｎ（ｔ１／ｔ０））／Ｃで計算される。ただし、式中ｔ１、ｔ０は、毛細管粘度計により測定される落下時間であって、ｔ１は溶液の落下時間、ｔ０は溶媒の落下時間である。Ｃは溶液１００ｍｌ中における重合体のｇ数で表した濃度である。対数粘度数、またはそれを用いて計算される固有粘度は、重合体の分子量と関係付けられる。

【００３５】上記のようにして得られたポリイミド前駆体の有機極性溶媒溶液を用い、例えば次のようにしてフレキシブル基板を製造する。

【００３６】（ａ）先ず、上記ポリイミドの前駆体の有機極性溶媒溶液を、導電性回路となる金属箔上にロールコータやコンマコータ等公知の手段を用いて流延塗布する。有機極性溶媒溶液中のポリイミド前駆体の濃度は５～３０重量％程度に設定することが好ましい。この濃度が５重量％より低いと得られるポリイミドの表面が荒れやすく、逆に高すぎると粘度が高くなって塗布作業性が低下する。

【００３７】前駆体の塗布厚さは限定されないが、最終的にポリイミドとして得られるフレキシブル基板の好ましい厚さが８μｍ～５０μｍであることから、このような厚さが得られるように塗布を行えばよい。

【００３８】導電性回路となる金属箔とフレキシブル基板であるポリイミドとの接着力を上げるために、金属箔の表面に対してサンドブラストをはじめ、コロナ放電やクロメート処理、あるいはシランカップリング剤や比較的柔らかいポリイミドをプライマー層として形成するなどの処理を施すことが好ましい。

【００３９】（ｂ）金属箔に対する上記溶液の流延塗布後、加熱処理してポリイミドを形成する。この加熱処理は、通常１００℃～２３０℃で３０分～２時間程度の加熱乾燥し溶媒を除去する工程と、さらに、２５０℃～６００℃の温度で１分～３時間加熱処理する工程を含む。

【００４０】上記（ａ）、（ｂ）の工程によって、金属箔表面に、上記式（Ａ）、（Ｂ）で表される構成単位（Ａ）、（Ｂ）からなるポリイミドが形成され、導電性回路となる金属箔と、フレキシブル基板との２層の積層体が得られる。

【００４１】このポリイミドは、構成単位（Ａ）、（Ｂ）によるブロック重合体であっても、ランダム重合体であっても、また交互重合体であってもよい。そして、構造単位（Ａ）と構造単位（Ｂ）とのモル比は、（Ａ）：（Ｂ）＝９０：１０～５０：５０の範囲に設定されなければならない。特に、（Ａ）：（Ｂ）＝８５：１５～６０：４０の範囲が好ましい。上記モル比において、構造単位（Ａ）のモル比の値が９０を越えると（逆に言うと構造単位（Ｂ）のモル比の値が１０未満であると）、ポリイミド皮膜の強度が著しく低下する。また、

構造単位（Ａ）のモル比の値が５０未満であると（逆に言うと構造単位（Ｂ）のモル比の値が５０を越えると）、得られるポリイミドの線膨張係数が大きくなり、プローブに用いて大きな温度変化を与えた場合に、検査対象物に対する大きなずれやプローブ自体に大きな反りが生じる。また、構成単位（Ｂ）を示す上記式（Ｂ）中のＸを上記のように選択することよって、耐熱性およびフレキシビリティの点で優れたポリイミドが得られる。

【００４２】導電性回路となる金属箔の材料としては、銅、ニッケル、半田、金、銀など一般公知の回路パターンに用いられる良導体金属であってもよいが、接触対象物が上記電子部品である場合には、バーンイン試験において、ズレだけでなく反りをも抑制し得るという点から、鉄－ニッケルの合金、特に、ニッケルを４２重量%含有する鉄－ニッケル合金（以下「４２アロイ」）が最も好適である。

【００４３】また、４２アロイだけを導電性回路として用いると、用途によっては導電性回路自体の抵抗値が高いことが問題となる場合があるが、その場合には、図４に示すように、導体が多重に積層された構造を有する導電性回路とし、フレキシブル基板１上に形成された４２アロイの導電性回路３ａ上に、上記良導体金属の層３ｂをさらに積層してもよい。４２アロイ層３ａに対する良導体金属層３ｂの積層は、金属箔単品の段階で積層する態様３１や、４２アロイからなる回路パターンに対して良導体金属をめっきする態様３２など、どの段階の工程において行なってもよい。

【００４４】導電性回路となる金属箔の厚さは１μｍ～５００μｍが好ましく、特に５μｍ～５０μｍがより好ましい。金属箔の厚さが１μｍより薄いと、箔の強度が無いため塗工が困難となり、５００μｍを越えると得られるプローブ全体が柔軟性に欠け、プローブの用途にふさわしくなくなるので好ましくない。

【００４５】導電性回路は、この回路基板を用いてプローブを製造する場合に、フレキシブル基板の面上に設けられる接点部と導通し得るように、該接点部の位置に対してフレキシブル基板の内部直下、真裏、またはこれらの近傍を通過するように設計し、形成する。導電性回路の態様は、回路パターンであっても、上記金属箔をそのまま加工せずに用いた導体層であってもよい。導電性回路を回路パターンとして形成する方法としては、アディティブ法やサブトラクティブ法など、公知の回路パターン形成方法が利用できるが、当該フレキシブル基板の製造工程からすれば、フレキシブル基板の形成後に金属箔をエッチング等によって回路パターンとするサブトラクティブ法が最も好ましい。

【００４６】上記のようにして得られた回路基板は、ポリイミドが極めて良好な寸法安定性を有しており、導電性回路の材料として４２アロイを用いることによって、電子部品に対するバーンイン試験などに用いられても、実質的にズレや反りが発生しないという優れた特性を備えている。

【００４７】次に、本発明のプローブを説明する。本発明のプローブは、上記回路基板を先ず形成しこれを用いて形成することが好ましいが、工程の順序は限定されず、例えば、回路パターンをプローブの加工工程中において完成させるなど、上記回路基板の構成要素を最終的に有するものであればよい。

【００４８】図１は、本発明によるプローブの基本的な構造の一例を示す模式図である。同図に示す例では、絶縁性を有するフレキシブル基板１の一方の面１ａに設けられた接点部２と、該フレキシブル基板の他方の面１ｂに設けられた導電性回路３とが導通された構造である。フレキシブル基板と導電性回路については、上記回路基板において説明したとおりである。

【００４９】接点部は、接触対象物の被接触部に対応する位置に設けられる。接点部は、接触対象物の被接触部に対して電気的な接触を行い得るものであればよく、通常は、良導体金属からなるバンプ接点（または単にバンプ）と呼ばれる突起状の接点の態様が用いられる。ただし、バンプ接点は、必ずしもフレキシブル基板面から突起する必要はなく、相手の形状に応じてフレキシブル基板面と同一面、凹面を形成するものであってもよい。また、接点部は、導電性回路の一部を接点部として用いる態様（リード接点）であってもよい。以下、接点部をバンプ接点とする場合について説明する。

【００５０】バンプ接点の材料としては、例えば金、銀、銅、鉛、クロム、亜鉛、アルミニウム、ニッケル、鉄、白金、パラジウム、ロジウム、ルテニウムなどが例示され、その構成は単一金属種だけでなく、異なる金属を層状に積層してもよい。異なる金属を層状に積層する場合は、最表面の金属としてはロジウム、ルテニウムといったヌープ硬度７００Ｈｋ～１２００Ｈｋのものを用いることが好ましい。

【００５１】バンプ接点は導電性回路と導通するように形成されるが、図１に示すように、フレキシブル基板の表／裏、または表面／深層で互いに対応する位置（互いに真下にある関係）に形成され、フレキシブル基板に設けられた貫通孔を通して導通される構造が好ましい構造である。このような導通の構造を有するバンプ接点の形成方法を、上記プローブ用の回路基板を用いた例として、次に概略的に説明する。

【００５２】先ず、図１に示すように、フレキシブル基板１の面１ａにおいて、導電性回路３の真裏に相当する位置（前記導電性回路が基板内部にある場合は真上に相当する位置）に貫通孔５を設け、その孔内底面に裏面１ｂの導電性回路３を露出させる。次に、孔内底面に露出した導電性回路の面を負極とする電解めっきによって、貫通孔内にバンプ接点の材料となる良導体金属を析出させて充填し、さらに析出を継続して、フレキシブル基板

の表面から良導体金属を突起させてバンプ接点２を得る。

【００５３】導電性回路をフレキシブル基板の内部に設ける方法としては、フレキシブル基板上に形成された導電性回路を、さらに可撓性と絶縁性とを有する材料によって被覆する方法が挙げられる。この場合、フレキシブル基板の材料と被覆に用いられる材料とは同じであっても異なるものであってもよいが、ともに上記ポリイミドとすることがより好ましい。

【００５４】フレキシブル基板に貫通孔を形成する方法としては、薬品、溶剤などを用いて化学的にエッチングを行うウエットエッチングや炭酸ガス、ＹＡＧ、エキシマなどのレーザー、あるいはプラズマなどを使ったドライエッチング法を用いることが出来る。特に微細な穴加工を行う場合にはレーザーを用いたエッチング法を用いることが好ましい。

【００５５】本発明のプローブの他の構造例を、図２（ａ）、（ｂ）に模式的に示す。図２（ａ）は、図１と同様の構成であるが、フレキシブル基板１と同様の材料からなる被覆層４によって、導電性回路３の全面を被覆することによって、導電性回路がフレキシブル基板の内部に設けられた構造となっている。Ｂは接触対象物である。図２（ｂ）は、導電性回路の導体自体を部分的に接点として用いた構造例である。また、接触対象物Ｂはベアチップであって、その被接触部Ｂ１はハンダバンプ接点の場合の例である。同図の例では、導電性回路３を部分的に露出させてリード状の接点部２とし、突起状の被接触部Ｂ１に対して、プローブ側の接点部２を微細で平坦な接触面としている。

【００５６】

【実施例】以下、実施例を挙げて本発明をより具体的に説明する。先ず、本発明によるプローブ用回路基板の製造例を次の実施例１～４に示し、それらを用いたプローブの製造例を実施例５、６に示す。ただし、下記において示す対数粘度は、上記と同様、溶媒にＮ－メチル－２－ピロリドンを用い、濃度０．５ｇ／１００ｍｌ、３０℃で測定したものである。また、ポリイミド前駆体の溶液粘度は、Ｂ型粘度計を用いて３０℃で測定したものである。

【００５７】実施例１

本実施例では、フレキシブル基板の材料として、上記式（Ａ）、（Ｂ）で表される構造単位（Ａ）、（Ｂ）からなるポリイミドを用い、特に、構造単位（Ｂ）に含まれる基Ｘを上記式（ｉ）で表される基とした。

【００５８】先ず、撹拌機および温度計を備えた容積５００ｃｃのセパラブルフラスコに、ｍ－トリジン（ＴＬＤ）１７．０ｇと、４，４’－ジアミノフェニルエーテル（ＤＤＥ）４．０ｇと、Ｎ－メチル－２－ピロリドン（ＮＭＰ）１７２ｇとを入れて撹拌し、前記ジアミノ化合物を溶解させた。

【００５９】次に、これにピロメリット酸二無水物（ＰＭＤＡ）２１．８ｇを徐々に加えその後３０℃以下の温度で５時間撹拌を続け、濃度２０％のポリイミド前駆体溶液を得た。このポリイミド前駆体溶液の対数粘度は１．９０であり、溶液粘度は８００Ｐａ・ｓであった。

【００６０】得られた溶液を、１５％ポリイミド前駆体溶液となるようにＮＭＰで希釈し、厚さ２０μｍの４２アロイ箔上にアプリケータを用いて流延塗布し、窒素雰囲気下で１００℃で３０分、２００℃で３０分、さらに４００℃で１時間の加熱を行いフレキシブル基板を作製した。フレキシブル基板の厚さは４５μｍであった。

【００６１】このポリイミドは、構造単位（Ａ）と（Ｂ）からなり、これらのモル比は、（Ａ）：（Ｂ）＝８０：２０であった。また、４２アロイ箔を含めた積層体としての面方向の線膨張係数は３．０×１０$^{-6}$であった。

【００６２】次に、４２アロイ箔の表面にフォトレジストを塗工し、露光、現像、エッチング、レジスト剥離により、バンプ接点を形成すべき所定位置の真裏を通過するよう設計した所定の回路パターン（導電性回路）を形成し、本発明によるプローブ用回路基板を得た。

【００６３】実施例２

本実施例では、上記実施例１と同様、フレキシブル基板の材料として構造単位（Ａ）、（Ｂ）からなるポリイミドを用いたが、構造単位（Ｂ）に含まれる基Ｘは上記式（ｉｖ）で表される基とした。

【００６４】先ず、実施例１と同様のセパラブルフラスコに、ＴＬＤ１８．０ｇと、２，２－ビス〔４－（４－アミノフェノキシ）フェニル〕プロパン６．２ｇと、ＮＭＰ１８４ｇとを入れて撹拌し、前記ジアミノ化合物を溶解させた。次に、これにＰＭＤＡ２１．８ｇを徐々に加えその後３０℃以下の温度で５時間撹拌を続け、濃度２０％のポリイミド前駆体溶液を得た。このポリイミド前駆体溶液の対数粘度は２．０５であり、溶液粘度は９５０Ｐａ・ｓであった。

【００６５】得られたポリイミド前駆体溶液と、厚さ３５μｍの４２アロイ箔とを用いて、上記実施例１と全く同様の工程にて、厚さ３８μｍのフレキシブル基板を作製した。このポリイミドは、構造単位（Ａ）と（Ｂ）からなり、これらのモル比は、（Ａ）：（Ｂ）＝８５：１５であった。また、フレキシブル基板としての面方向の線膨張係数は３．３×１０$^{-6}$であった。

【００６６】次に、上記実施例１と全く同様に、４２アロイ箔を回路パターン（導電性回路）として加工し、本発明によるプローブ用回路基板を得た。

【００６７】実施例３

本実施例では、上記実施例１と同様、フレキシブル基板の材料として構造単位（Ａ）、（Ｂ）からなるポリイミドを用いたが、構造単位（Ｂ）に含まれる基Ｘを上記式（ｖ）で表される基とした。

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【００６８】実施例１と同様のセパラブルフラスコに、ＴＬＤ１９．１ｇと、２，２－ビス〔４－（アミノフェノキシ）フェニル〕ヘキサフルオロプロパン５．２ｇと、ＮＭＰ１８４．４ｇとを入れて撹拌し、前記ジアミノ化合物を溶解させた。次に、これにＰＭＤＡ２１．８ｇを徐々に加えその後３０℃以下の温度で５時間撹拌を続け、濃度２０％のポリイミド前駆体溶液を得た。このポリイミド前駆体溶液の対数粘度は１．８５であり、溶液粘度は８４０Ｐａ・ｓであった。

【００６９】得られたポリイミド前駆体溶液をＮＭＰで１５％に希釈し、厚さ３５μｍの４２アロイ箔上にアプリケータを用いて流延塗布し、窒素雰囲気下で１００℃で３０分、２００℃で３０分、さらに４００℃で１時間の加熱を行い、厚さ６０μｍのフレキシブル基板を作製した。

【００７０】このポリイミドは、構造単位（Ａ）と構造単位（Ｂ）からなり、これらのモル比は（Ａ）：（Ｂ）＝９０：１０であった。また、フレキシブル基板としての面方向の線膨張係数は３．４×１０$^{-6}$であった。

【００７１】次に、上記実施例１と全く同様に、４２アロイ箔を回路パターン（導電性回路）として加工し、本発明によるプローブ用回路基板を得た。

【００７２】実施例４

本実施例では、フレキシブル基板の材料として、構造単位（Ａ）、（Ｂ）、および構造単位（Ｂ）に含まれる基Ｘが、全て上記実施例１と同様であるが、構造単位（Ａ）と構造単位（Ｂ）のモル比が（Ａ）：（Ｂ）＝５０：５０であるポリイミドを用いた。

【００７３】先ず、実施例１と同様のセパラブルフラスコに、ＴＬＤ１０．６ｇと、４，４′－ジアミノジフェニルエーテル１０．０ｇと、ＮＭＰ１６８．８ｇとを入れて撹拌し、上記ジアミノ化合物を溶解させた。次に、これにＰＭＤＡ２１．８ｇを徐々に加えその後３０℃以下の温度で５時間撹拌を続け、濃度２０％のポリイミド前駆体溶液を得た。このポリイミド前駆体溶液の対数粘度は１．８０であり、溶液粘度は７２０Ｐａ・ｓであった。

【００７４】得られたポリイミド前駆体溶液と、厚さ３５μｍの４２アロイ箔を用いて、上記実施例１と全く同様の工程にて、厚さ６０μｍのフレキシブル基板を作製した。このポリイミドは、構造単位（Ａ）と（Ｂ）からなり、これらのモル比は、（Ａ）：（Ｂ）＝５０：５０であった。また、フレキシブル基板としての面方向の線膨張係数は６．５×１０$^{-6}$であった。

【００７５】次に、上記実施例１と全く同様に、４２アロイ箔を回路パターン（導電性回路）として加工し、本発明によるプローブ用回路基板を得た。

【００７６】実施例５

上記実施例１～４において作製したプローブ用回路基板を用いて、これら各々にバンプ接点を形成し、図１に示す構造のプローブを計４種類作製した。バンプ接点の形成工程を次に示す。

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【００７７】先ず、プローブ用回路基板において、フレキシブル基板の両面のうち導電性回路が形成された面とは反対側の面に対して、バンプ接点を形成すべき位置に炭酸ガスレーザーをマスク投影＋ガルバノスキャン法にて照射し、内径８０μｍの貫通孔を形成し、該貫通孔の内部底面に導電性回路を露出させた。次に、導電性回路の表面（貫通孔の内部底面に露出した部分を除く）に、めっきに対するレジスト膜を施した後、導電性回路を負極とする電気めっきにて貫通孔内にＮｉを析出させ充填した後さらに析出を継続し、基板面からの突起高さが２０μｍのバンプ接点を形成し、さらにその表面に１μｍの厚さで金めっきを行い、さらに１μｍの厚さでロジウムめっきを行い、レジスト膜を剥離して、本発明によるプローブを得た。

【００７８】本実施例で得た４種類のプローブに、接触対象物として６インチウエハを密着させて、室温２５℃～１５０℃のバーンインサイクルにかけた後、ウエハとプローブの各接触部の表面を観察したところ、どのウエハの接触点にもバンプ接点のずれによる大きな痕は発生しておらず、また、プローブ側のバンプ接点表面にもダメージは見られなかった。また、プローブ自体には使用上問題となるような反りはなかった。

【００７９】実施例６

本実施例では、上記実施例１～４において作製したプローブ用回路基板に対して、さらに導電性回路をポリイミドで被覆し、導電性回路がフレキシブル基板の内部に設けられた構造とし、これにバンプ接点を設けて図２（ａ）に示す構造のプローブとした。

【００８０】実施例１～４と全く同様に、フレキシブル基板の一方の面に対して導電性回路を形成した後、さらに、この導電性回路を、外部計測機器との接続に用いられる部分を除いて、各々のフレキシブル基板の材料と同じポリイミドからなる被覆層４によってカバーコートした。

【００８１】フレキシブル基板の両面のうち導電性回路が形成された面とは反対側の面に対して、バンプ接点を形成すべき位置に、波長２４８ｎｍのエキシマレーザーをマスク投影法にて照射し、内径３０μｍの貫通孔を形成し、該貫通孔の底面に導電性回路を露出させた。導電性回路の外部接続端子部に、めっきに対するレジスト膜を施した後、導電性回路を負極とする電気めっきにて貫通孔内にＮｉを析出させ充填した後さらに析出を継続し、基板面からの突起高さが２５μｍのバンプ接点を形成し、さらにその表面に１μｍの厚さで金めっきを行い、さらに１μｍの厚さでロジウムめっきを行い、レジスト膜を剥離して、本発明によるプローブを得た。

【００８２】本実施例で得た４種類のプローブに、接触対象物としてベアチップを密着させて、室温２５℃～１

２５℃のバーンインサイクルにかけた後、ベアチップとプローブの各接触部の表面を観察したところ、どのベアチップの接触点にもバンプ接点のずれによる大きな痕は発生しておらず、また、プローブ側のバンプ接点表面にもダメージは見られなかった。また、プローブ自体には使用上問題となるような反りはなかった。

【００８３】比較例１

本比較例では、フレキシブル基板の材料として、本発明で用いるポリイミドとは構成単位の異なるポリイミドを用いてプローブ用回路基板を作製した。先ず、実施例１と同様のセパラブルフラスコに、ＴＬＤ２１．２ｇと、ＮＭＰ１７２ｇとを入れて撹拌し、前記ジアミンを溶解させた。次に、これにＰＭＤＡ２１．８ｇを徐々に加えその後３０℃以下の温度で５時間撹拌を続け、濃度２０％のポリイミド前駆体溶液を得た。このポリイミド前駆体溶液の対数粘度は１．８５であり、溶液粘度は７５０Ｐａ・ｓであった。

【００８４】得られたポリイミド前駆体溶液と、厚さ２０μｍの４２アロイ箔とを用いて、実施例１と同様の工程にて、厚さ３３μｍのフレキシブル基板を作製した。このフレキシブル基板は、上記作製工程が完了した時にすでに、４２アロイ箔側を内側にして大きくカールしており、回路基板としてプローブ製造に使用できる品質レベルのものではなかった。また、フレキシブル基板としての面方向の線膨張係数は-6.0×10^{-6}であった。

【００８５】比較例２

比較例１と同様、フレキシブル基板の材料として、本発明で用いるポリイミドとは構成単位の異なるポリイミドを用いてプローブ用回路基板を作製した。先ず、実施例１と同様のセパラブルフラスコに、４，４′－ジアミノジフェニルエーテル（ＤＤＥ）２０ｇと、ＮＭＰ１６８ｇとを入れて撹拌し、前記ジアミンを溶解させた。次に、これにＰＭＤＡ２１．８ｇを徐々に加え、３０℃以下の温度で５時間撹拌を続け、濃度２０％のポリイミド前駆体溶液を得た。このポリイミド前駆体溶液の対数粘度は２．２０であり、溶液粘度は１０００Ｐａ・ｓであった。

【００８６】得られたポリイミド前駆体溶液と、厚さ１５μｍの４２アロイ箔とを用いて、実施例１と同様の工程にて、厚さ４０μｍのフレキシブル基板を作製した。このフレキシブル基板は、比較例１の場合と同様に、上記作製工程が完了した時にすでに、４２アロイ側を内側にして大きくカールし、回路基板としてプローブの製造に使用できる品質レベルのものではなかった。また、フレキシブル基板としての面方向の線膨張係数は32.5×10^{-6}であった。

【００８７】比較例３

本比較例では、フレキシブル基板の材料として、構造単位は本発明（実施例２）と同様であるが、構造単位（Ａ）と構造単位（Ｂ）のモル比が本発明で示した範囲外であるポリイミドを用いてフレキシブル基板を作製した。先ず、実施例１と同様のセパラブルフラスコに、ＴＬＤ２０．１ｇと、２，２－ビス〔４－（４－アミノフェノキシ）フェニル〕プロパン２．１ｇと、ＮＭＰ１７５．２ｇとを入れて撹拌し、前記ジアミノ化合物を溶解させた。次に、これにＰＭＤＡ２１．８ｇを徐々に加え、３０℃以下の温度で５時間撹拌を続け、濃度２０％のポリイミド前駆体溶液を得た。このポリイミド前駆体溶液の対数粘度は１．８５であり、溶液粘度は８３０Ｐａ・ｓであった。

【００８８】得られたポリイミド前駆体溶液と、厚さ３５μｍの４２アロイ箔とを用いて、実施例１と同様の工程にて、厚さ６０μｍのフレキシブル基板を作製した。フレキシブル基板を形成するポリイミドの構造単位は実施例２と同様であるが、構造単位（Ａ）と（Ｂ）とのモル比は、（Ａ）：（Ｂ）＝９５：５であった。また、フレキシブル基板としての面方向の線膨張係数は-1.0×10^{-6}であった。得られたポリイミドは可とう性が無く、強度的にもフレキシブル基板として使用できるものではなかった。

【００８９】比較例４

本比較例では、比較例３と同様に、フレキシブル基板の材料として、構造単位は本発明（実施例２）と同様であるが、構造単位（Ａ）と構造単位（Ｂ）のモル比が本発明で示した範囲外であるポリイミドを用いてフレキシブル基板を作製した。先ず、実施例１と同様のセパラブルフラスコに、ＴＬＤ９．５ｇと、２，２－ビス〔４－（４－アミノフェノキシ）フェニル〕プロパン２２．６ｇと、ＮＭＰ２１４．８ｇとを入れて撹拌し、前記ジアミノ化合物を溶解させた。次に、これにＰＭＤＡ２１．８ｇを徐々に加えその後３０℃以下の温度で５時間撹拌を続け、濃度２０％のポリイミド前駆体溶液を得た。このポリイミド前駆体溶液の対数粘度は２．０５であり、溶液粘度は９５０Ｐａ・ｓであった。

【００９０】得られたポリイミド前駆体溶液と、厚さ３５μｍの４２アロイ箔とを用いて、実施例１と同様の工程にて、厚さ６０μｍのフレキシブル基板を作製した。このフレキシブル基板を形成するポリイミドの構造単位は実施例２と同様であるが、構造単位（Ａ）と（Ｂ）とのモル比は、（Ａ）：（Ｂ）＝４５：５５であった。また、フレキシブル基板としての面方向の線膨張係数は12.0×10^{-6}であった。

【００９１】次に、上記実施例１と全く同様に、４２アロイ箔を回路パターン（導電性回路）として加工し、さらに、実施例５と同様の工程にてプローブを作製した。

【００９２】本比較例で得たプローブに、接触対象物としてベアチップを密着させて、室温２５℃～１５０℃のバーンインサイクルにかけた後、ベアチップとプローブの各接触部の表面を観察したところ、ベアチップのパッド部には数十μｍにわたってバンプ接点の動いたキズが

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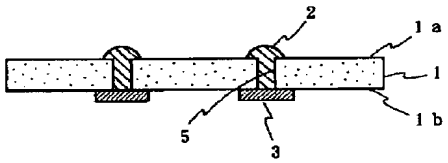
発生していた。

【００９３】

【発明の効果】上記説明および実施例の結果からも明らかなように、本発明のプローブを例えば検査用プローブとして用いた場合には、バーンイン試験などの激しい温度変化にさらされても、プローブには反りが発生し難く、しかも優れた寸法安定性を示す。これによってバンプ接点と被接触部とのズレも少なく、接触信頼性および検査装置としての耐久性も向上する。また、実装用の接続具として用いた場合にも、激しい温度変化が作用する使用環境のもとでも、優れた接続の信頼性を示すものとなる。

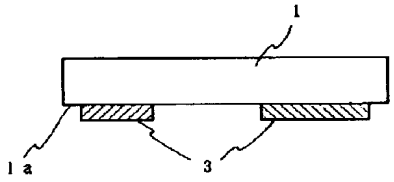
【図面の簡単な説明】

【図１】



1　フレキシブル基板
2　接点部
3　導電性回路

【図３】



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＊【図１】本発明によるプローブの基本的な構造の一例を示す模式図である。

【図２】本発明によるプローブの他の構造例を示す模式図である。

【図３】本発明のプローブに用いられる回路基板の構造の一例を示す模式図である。

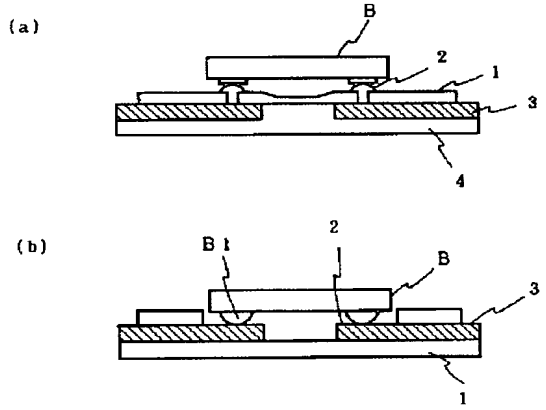
【図４】本発明の回路基板における導電性回路の構造例を示す模式図である。

【符号の説明】

1　フレキシブル基板
2　接点部
3　導電性回路（回路パターン）

＊

【図２】



【図４】